Printed Ultra-High Temperature NDE Sensors for Complex Structures, Phase I

Completed Technology Project (2016 - 2016)

Project Introduction

This Phase I SBIR proposal will address the use of innovative additive manufacturing technologies applicable to Non-Destructive Evaluation (NDE) and Structural Health Monitoring (SHM) strain and temperature sensors at ultra-high temperatures up to 1000 C. Technologies are required that enable flaw detection on atmospheric and space flight vehicles during deep space missions, hypersonic flight and reentry in harsh environments including high temperatures, combustion, high vacuum, high pressure, vibration, turbulence and cryogenic space conditions. Accurate strain gage readout at high and varying temperatures also requires temperature sensing for calibration. The prior art technologies of making strain gages and thermocouples have distinct limitations in direct application/integration to large 3D parts, cost, weight/resolution/feature size and operation to high temperatures. Direct-write printing has established itself as an enabling technology for production of both circuits and sensors on 3D and flexible surfaces that could not otherwise be fabricated with conventional techniques. This project will develop the specialized inks and deposition techniques necessary to implement additive manufacturing of hardened ultra-high temperature, lightweight strain gages and thermocouples with low profiles suitable for thin components. Fully integrated and modular sensors and arrays can be implemented for NDE and SHM of complex parts and hard-to-address locations that were previously out-of-bounds. Hardened inks may be applied by a variety of additive manufacturing techniques directly onto three-dimensional components or on high temperature substrates that can be adhered to complex components by refractory joining. High temperature stable strain gages will be proven feasible in Phase I to a Technology Readiness Level of at least 3. Phase II work on readout technology will focus on wireless techniques to take data remotely at high temperatures and on embedded components.

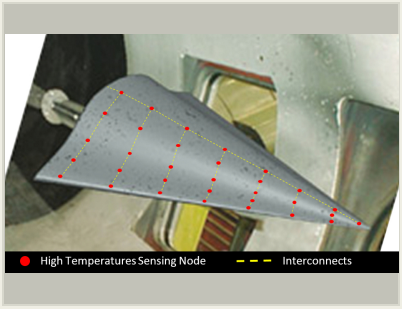

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Table of Contents

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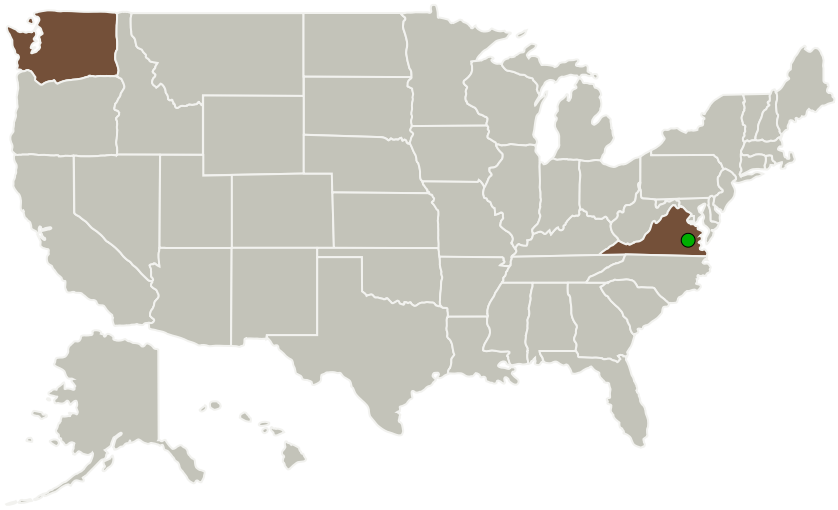
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Quest Integrated, LLC	Lead Organization	Industry Small Disadvantaged Business (SDB)	Kent, Washington
Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia

Primary U.S. Work Locations	
Virginia	Washington

Project Transitions

June 2016: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Quest Integrated, LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

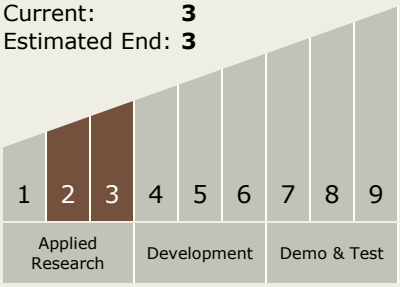
Carlos Torrez

Principal Investigator:

Vincent Fratello

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



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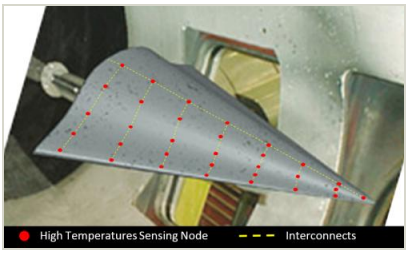
December 2016: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/139624)*

Images



Briefing Chart Image
Printed Ultra-High Temperature NDE Sensors for Complex Structures, Phase I
(https://techport.nasa.gov/image/132855)

Final Summary Chart Image
Printed Ultra-High Temperature NDE Sensors for Complex Structures, Phase I Project Image
(https://techport.nasa.gov/image/129920)

Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors
    - TX08.1.1 Detectors and Focal Planes

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System